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AUTHOR Otto, Paul B.
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ABSTRACT

Writing in general is purported to be an all-important, most neglected area in education, especially in the area of science teaching. Several recognized authorities in the field of writing advocate that writing be taught in all the disciplines as well as in English. Since writing as a "process" rather than a "product" has been suggested by writing authorities, this study was conducted to compare the effect of writing as a process with the effect of writing as a product on the written communication skills of undergraduate students enrolled in a preservice physical science course for elementary school teachers. A pretest/posttest control group design was used. During the semester, control group students wrote papers on experiments they conducted; these papers were graded and returned without written comments. Experimental group students also wrote similar papers; however, these papers were returned without letter grades and with instructions to rewrite the papers based on comments provided by the instructor. To determine if a change in writing competency had taken place, all students wrote a two-page personal experience paper at the beginning (pretest) and end (posttest) of a semester. Results obtained from analyses of these papers show no difference in writing competency between experimental and control group students. (JN)

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Writing as a Process in a University Physical Science Class

Paul B. Otto

University of South Dakota

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INTRODUCTION

Communication is recognized as an important activity in science. The American Association for the Advancement of Science Commission on Science Education identified communication as a basic science process skill for elementary school students of science. The Wisconsin Department of Public Instruction A GUIDE TO SCIENCE CURRICULUM DEVELOPMENT stated that communicating scientific information is a major aspect of the nature of the scientific enterprise which obligates the scientist to publish new research results so that all members of the academic community may benefit or have the opportunity to test formulated concepts (1).

Writing is, of course, the workhorse of communication in science and science education. Research findings, theories, critiques and rebuttals are routinely disseminated through technical reports, journal articles and the presented paper. Physicist James Van Allen contrasts the doing of science as non-verbal with the communication of one's findings as verbal. He ascribes written communication a high priority in his statement "--- for nothing will persuade me that writing is not an essential part of doing science" (2). Funk and Okey consider writing as a basic form of the science process "Communication" which is frequently used in science (3). Paul DeHart Hurd argues that a substantial part of the science curriculum should have a science/technology/society orientation including such intellec-

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tual skills as "a command of basic communicative and expressive skills including reading, writing, speaking, listening and computing" (4). Likewise, the National Science Board Commission on Precollege Education in Mathematics, Science and Technology recommended that science, mathematics and technology courses involve the solution of practical problems for the purpose, among others, "to sharpen the student's ability to communicate verbally and to write precisely" (5).

One of the major goals of science education is the promotion of scientific literacy. Scientific literacy is not the direct outcome of learning science, according to Hurd (6), but rather it stems from experiences of interactions between science, society and technology. Two attributes ascribed to the scientifically literate person by Collette and Chiappetta (7) are: 1) The ability to use the processes of science to solve problems and to make daily decisions and 2) Science process skills that permit him or her to function in work, leisure and in society in general. Daniel Hade (8) states that the true command of literacy occurs with the mastery of creation in the media of communication. This is reinforced by Neil Postman's (9) definition of literacy "as the ability to manipulate the media of communication." Eugene Garfield (10) speaks of the present-day "information society." Presently, the "information" industry accounts for over 50 percent of the gross national product and utilizes over 50 percent of the work force (11). Hade (12) argues that to be literate in the information society, one needs the knowledge to function as a sender of messages in addition to being informed.

Given the importance of writing in general and specifically in the area of science, who then is responsible for its teaching? Is the teaching of writing soley within the realm of the Departments of English or is it a shared responsibility? Considerable advocacy can be found for the latter case.

Recently, the Carnegie Report "High School: A Report on Secondary Education in America" declared that "Writing should be taught in every class." Writing is an interdisciplinary learning activity with a place in every classroom according to Toby Fulwiler, Dan Fader and James Britton, recognized authorities in the field of writing (13). Lee Odell (14) advocates the teaching of writing in classes other than English at the university level.

NEED FOR THE STUDY

The writer, through grading laboratory experiment reports written by students in the preservice course Physical Science for Elementary Teachers, has observed the need for improving the writing competencies of university students, especially those who in the near future will be teaching children in the elementary schools. If we wish to develop good writing skills in our elementary school students, it would seem reasonable to expect their teachers to be able to write.

Traditionally, writing has been viewed as informing and tends to be something done after the learning takes place. The main concern of the teacher is in criticizing the "product" rather than facilitating the "process" of composition (15). Freisinger (16) interprets this unimodal behavior as implying a misunderstanding of the composing process or its gross oversimplification. The case is made, that students will better acquire the skills of adequate written communication, when taught writing as a process rather than a product (17, 18, 19 & 20).

Previous studies of writing as a process have involved a variety of models and have shown both effect and non-effect. Effros (21) reported that students whose competition revisions were teacher-guided and whose work was not graded until such revisions were completed achieved no better than students whose work was immediately graded and revisions were treated

incidentally. However, the essay posttest may have been biased by being conducted under test conditions. Studies by Gottschalk (22) and Scannella (23) revealed no significant difference in the effect of Product-oriented and Process-oriented models of teaching Composition on the improvement of writing ability of students. Rewriting or revision of essays showed no significant gains in the composition skills of students in studies conducted independently by Hansen (24) and Walkup (25). The work of Buxton (26) appears to support the use of writing and revisions as means of improving writing skills, but it is not clear whether marking and grading were factors of influence.

PROCEDURES

The purpose of this study was to compare "writing as a process" with "writing as a product" as an effect on the written communication skills of undergraduate students enrolled in a preservice University Physical Science for Elementary Teachers class.

The project was conducted during the 1983-84 academic year employing a pretest-posttest-control group design. All of the students enrolled in the University Physical Science for Elementary Teachers (PSET) course were involved in the project. The PSET course is a single offering so students may enroll for one semester only. All writing assignments and student groupings were conducted as regular class activities with the students unaware that they were contributing to a special project.

One of the three sections from the fall semester was designated the Control Group and two of the sections as the Experimental Group. Only two sections were enrolled in the course during the spring semester. All sections were assigned a two-page personal experience paper at the beginning of each semester (pretest) and at the end of each semester (posttest) for

judging a change in writing competency during the semesters.

All students in the class were assigned three short theme papers in respect to experiments they conducted during the course. Topics were revealed only when the writing assignments were made and after completion of the experiments. All students were involved in identical class activities other than the writing project.

The Control Groups handed in the writing assignments at the designated time. The researcher read the assignments and graded them. The papers were returned with written comments and any questions asked by students were answered.

The Experimental Groups were given the same writing assignments with identical "due dates" as the Control Groups. The principal researcher read the assignments and returned the papers with written comments, but no grade. The papers were handed back and the students were directed to rewrite the papers observing the written comments as well as to seek the consultantship of outside sources, such as colleagues or teachers. The final papers were handed in with the original draft, graded by the principal researcher and handed back with written comments.

The posttests (personal experience papers) were assigned to all sections during the final week of the semesters. No grades or feedback were given for the personal experience papers.

A panel of readers was established to rate the pre and posttest personal experience papers during the summer of 1984. Fourteen public school educators participated in a training session based on a rubric for scoring articles of writing. A short orientation on the rubric was followed by the panel individually rating a sample of written composition which in turn was followed by the raters discussing the reasons for their ratings. The process was

repeated with a series of papers, none of which were part of the sample utilized in the study, until a total of eight papers were rated. It was decided that the frequency of agreement of rater scores was adequate (see Table I). The panel was then given the assigned papers for rating.

TABLE I

Frequency of Rater Scores

	Papers							
Frequency	1	2	3	4	5	6	7	8
1	0	1	0	0	0	0	0	0
2	3	4	2	0	0	1	0	0
3	4	2	2	0	0	3	3	0
4	3	6	4	3	1	8	4	0
5	0	1	1	4	1	1	3	1
6	4	0	0	2	5	1	2	6
7	0	0	2	5	5	0	2	6
8	0	0	2	0	2	0	0	1

RESULTS

The pretest papers of each class member was matched with a corresponding posttest paper and assigned a number from one through ninety seven. Fourteen each of the matched pairs of papers respectively were randomly selected from the Control Group and the Experimental Group of papers. Four each of the selected papers were randomly assigned to seven of the raters and also to the other seven raters. In essence, each paper was read independently by two different readers.

The numerical ratings were submitted to analysis of the covariance with the pretest as the covariate. Inspection of Table II indicates the analysis

of the covariance was not significant for the treatment at the 0.05 level.

TABLE II

Analysis of Covariance for Comparing Experimental and Control Groups

Source	df	SS	F
Group (experimental vs. control)	1	0.03	0.02
Pretest (Covariate)	1	5.60	3.01
Error	25	46.48	

The means and standard deviations for the Control and Experimental groups are represented in Table III.

TABLE III

Mean Pre and Post Rating Scores

	Pre		Post	
	$\bar{X}$	SD	$\bar{X}$	SD
Experimental	6.57	1.27	6.25	1.33
Control	5.71	1.20	5.86	1.50

A comparison of the means shows very little change from the pre to post in either group. Computation of the Spearman-Brown Prophecy average for two raters revealed the interater reliability of the readers in reading the assigned papers to be 0.49.

IMPLICATIONS FOR TEACHING SCIENCE

Considerable literature in the field of writing advocates the teaching of writing as a "process" in fields of writing other than the field of English. The writer was, during the summers of 1982 and 1983, a participant in a one

week workshop designed to promote writing as a process in fields other than English. Recognized experts in "writing across the curriculum" directed writing as process activities.

It seems logical that writing can be improved if it is practiced in courses other than English. However, the present study does not demonstrate that writing as a process in a Physical Science class at the university level improves general writing skills.

It is possible that the assignments given need to be investigated as well as the methodology for providing feedback to the students. The "writing as a process" may make the student dependent upon professor feedback causing dependency for revision, thereby bypassing important cognitive processes. Perhaps the teacher of science needs special training in providing feedback to the student in respect to writing critique, although the writer had attended two one-week in-service sessions.

The question of accuracy of the rating process is always an area of concern. The panel of readers in this study consisted of elementary school principals, elementary school teachers and one each counselor and secondary school principal. Scores on papers read during the training session progressively showed increasing agreement, with a close clustering of agreement at the end of the eighth paper. However, interater reliability for two readers during the actual reading of the papers for the study was 0.49. An interesting study would be to run the same analysis with a panel consisting soley of writing teachers trained in the rubric.

Certainly this study does call for a closer look at the process that does not appear to have research support from the literature, but tends to be advocated by specialists in the field.

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